PROBLEMS OF QUALITY

UDC 666.172.053.5:621.9.025.7

COST AND QUALITY OF GRINDING HOUSEHOLD AND FANCY GLASS AS A FUNCTION OF DIAMOND CONCENTRATION IN GRINDING WHEELS

A. V. Popov[1]

Translated from Steklo i Keramika, No. 10, pp. 11 – 12, October, 2001.

We show the expediency of using grinding wheels with 50% concentration of diamond powder of grade AS15 and grinding wheels with 35 – 50% concentration of diamond power of grade AS6 for treatment of household and fancy glass in further chemical polishing.

Household and fancy glass in domestic glass factories is treated employing diamond grinding wheels, which meet the technical standard GOST 30352–96 with a diamond concentration equal to 35, 50, and 100%. Factories in the Czech Republic traditionally producing household and fancy glass [1] use wheels with a diamond concentration of 40 and 50%. In order to determine the optimum concentration of diamond powder that would ensure the minimum production cost together with the required quality level, a study was performed to clarify the effect of diamond concentration on the cutting capacity of the grinding wheel, the specific diamond consumption, the unit cost of treatment, and the roughness of the treated surface.

The study was performed in accordance with the method regulated by GOST 30352–96 on a special stand made on the basis of a universal tool-grinding machine [2]. A sample was pressed to the grinding wheel with a counterweight acting via blocks installed on the machine frame, and the clamp force was monitored with a dynamometer with sensitivity 1 N. The clamping force was 40 N. The grinding depth was set at 3 mm and monitored by a depth gage with sensitivity 0.1 mm. Grinding was carried out using wheels of the shape 1E1 $100 \times 6 \times 6 \times 90° \times 32$ on M2-01 binder with hardness (85 ± 5) *HRB*. The grinding diamond powders used in the experiments had grain size 63/50 and 75/63 for grades AS6 and AS15 (GOST 9206–80). The speed of the wheel was 26 m/sec.

Grinding was performed on glass bars $150 \times 100 \times 20$ mm containing 24% PbO. Water served as lubricant-coolant. The specific consumption of diamonds was determined by weighing on a VLT-1-1 scale with a measurement error of 0.01 g. The treatment duration in determining the cutting capacity of the wheel was monitored by a SOPr-2a-2 stop-watch with sensitivity 0.2 sec. To determine the average value of the specific diamond consumption and the cutting capacity of the wheel, each experiment was repeated 5 times. The roughness of the treated surface was measured using a model 201 profilograph-profilometer made at the Kalibr Works.

It was found that in using AS6 and AS15 diamond powders, the maximum cutting capacity is accomplished when using grinding wheels with a diamond concentration of 35%. A decrease in the diamond concentration to 20% decreases the cutting capacity by a factor of 1.1, an increase in the concentration to 50% makes the cutting capacity 1.05 – 1.2 times lower, and an increase in the concentration to 100% makes the cutting capacity 1.25 – 1.75 times lower (Fig. 1*a*).

For the specified diamond powders the minimum specific consumption of diamonds is accomplished using grinding wheels with diamond concentration 35%. A decrease in the diamond concentration to 20% increases the specific diamond consumption 1.2 – 1.3 times, an increase in the concentration to 50% — 1.1 times, and bringing the concentration to 100% — 1.3 – 1.4 times (Fig. 1*b*).

The studies performed by the authors in [3, 4] showed that such criteria of grinding wheel performance as its cutting capacity and the specific consumption of diamond cannot uniquely characterize the efficiency of grinding. To provide an economic substantiation for the selection of the

[1] VeAl Joint-Stock Company, Venev, Ukraine.

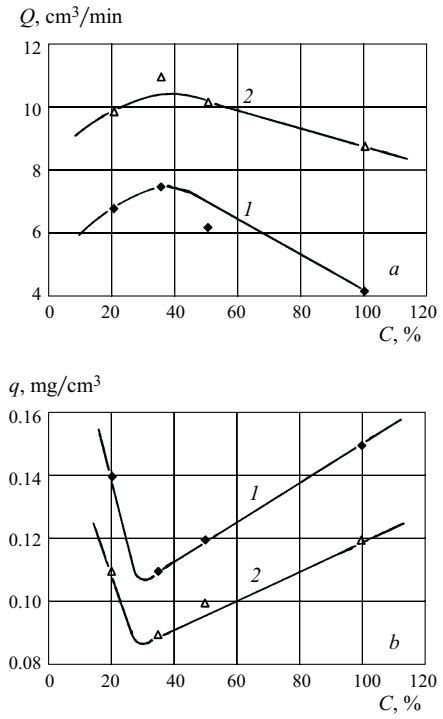

Fig. 1. Cutting capacity of the wheel Q (*a*) and specific consumption of diamond q (*b*) depending on concentration C of powders AS6 (*1*) and AS15 (*2*) with grain size 75/63.

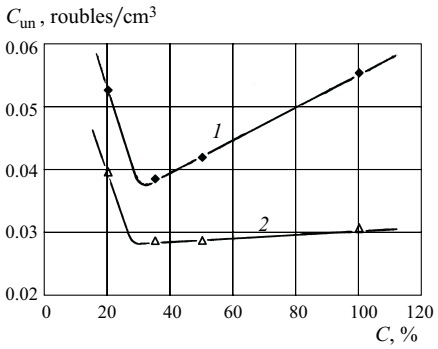

Fig. 2. Unit cost C_{un} depending on concentration C of powders AS6 (*1*) and AS15 (*2*) with grain size 75/63.

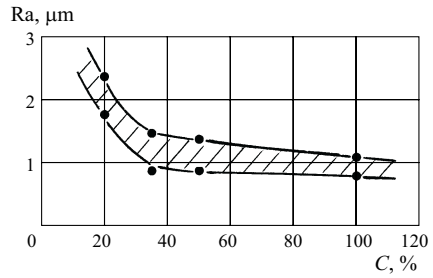

Fig. 3. Roughness of treated surface Ra depending on concentration C of powders with grain size 63/50.

grinding wheel parameters, it was recommended to use the unit cost of treatment:

$$C_{un} = \frac{C_1 + C_2 + C_3 + C_4 + C_5 + C_6}{V},$$

where C_1 is the hourly wages of the machine operator, rubles; C_2, C_3, C_4, C_5, and C_6 are, respectively, the hourly cost of machinery depreciation, the cost of tools, equipment repair, electricity, and building depreciation, rubles; V is the hourly volume of the ground glass, cm^3.

In determining the cost of the tools it was taken that in manual treatment of household and fancy glass, 25% of the diamond layer on a grinding wheel is consumed in restoring its cutting capacity in dressing [5]. The calculation was based on the prices of the Venev Diamond Tool Works (VeAl JSC).

It was found that in using AS6 diamond powder, the minimum unit cost is accomplished by using grinding wheels with diamond concentration 35%. A decrease in the diamond concentration to 20% increases the unit cost of treatment 1.35 times, an increase in the concentration to 50%, 1.1 times, and when the concentration is 100%, it grows 1.45 times (Fig. 2).

In using AS15 diamond powder, the minimum unit cost is accomplished by using grinding wheels with diamond concentration 35 – 50%. A decrease in the diamond concentration to 20% increases the unit cost of treatment 1.4 times, and when the concentration is 100%, it increases 1.07 times.

The analysis of the unit cost of treatment depending on the diamond concentration in grinding wheels showed that the use of AS15 grinding powder allows for a 25% reduction in the unit cost of treatment, compared to diamond powder AS6 (Fig. 2).

As a consequence of measuring the roughness of the treated surface, it was established that an abrupt increase in roughness takes place with an increasing concentration of diamonds in the grinding wheels above 35%. Thus, in using wheels with diamond concentration 20%, the roughness increases 1.7 times compared to the wheel with 35% diamond concentration (Fig. 3). The use of wheels with 50% diamond concentration decreases the roughness of the treated surface 1.1 times, and when the concentration is 100%, the roughness is 1.25 times lower compared to the wheel with 35% diamond concentration. An increase in the roughness of the treated surface requires extended chemical polishing of household and fancy glass and, consequently, increases the production cost of the articles.

Thus, in treatment of household and fancy glass it is advisable to use grinding wheels with 50% concentration of grade AS15 diamond powder and grinding wheels with 35 – 50% concentration of grade AS6 diamond powder.

The use of grinding wheels with AS15 diamond powder makes it possible to lower the unit cost of treatment by 25% compared to grinding wheels with diamond powder AS6.

REFERENCES

1. P. Daniel, “The Proud Tradition of Crystal,” *Ind. Diamond Rev.*, No. 1, 1 – 3 (1992).
2. A. V. Popov, “Performance parameters of diamond grinding wheels for grinding household and fancy glass,” *STIN*, No. 12, 30 – 31 (2000).
3. M. F. Semko, M. D. Uzunyan, and É. P. Ufa, *Economic Justification of the Choice of a Diamond Wheel* [in Russian], Prapor, Kharkov (1971).
4. M. F. Semko, A. I. Grabchenko, A. F. Rab, et al., *Principles of Diamond Grinding* [in Russian], Tekhnika, Kiev (1978).
5. O. V. Khimach, M. A. Pererozin, V. M. Nemets, et al., “Electric contact dressing of diamond wheels in treating cut glass on SAG machines,” *Sverkhtverd. Mater.*, No. 2, 62 – 64 (1987).